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Micro & Nanostructural characterization of 2,25Cr-1,6W(V) ASTM A213 T23 ferritic steels

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Abstract – Three steels based on the ASTM A213 T23 alloy, with changing in the amounts of W and B were cast, forged and subjected to artificial aging up to 5000h at temperatures of 550°C, 600°C and 650°C. The mechanical and nanostructural characterization revealed the role of the W and B. The behavior of the hardness as a function of aging temperature and time and the role of carbides on the precipitation hardening were also evaluated.

Three different steels with chemical compositions based on bainitic steel 2,25Cr-1,6W(V) ASTM A213 T23 were cast and forged. The effects of nanostructural changes caused by chemical composition modifications of these alloys (amounts of W and B) and their role in mechanical properties changes were evaluated by accelerated creep tests on the new and aged samples (aging up to 5000h at temperatures of 550°C , 600°C and 650°C), followed by hardness tests, scanning and transmission electron microscopy characterization. These tests revealed an inconsistent hardness behavior for this steel, Fig.1, and enabled the mapping of distribution of the carbide precipitation, Fig.2, besides the observation of consistent signs of high temperature degradation, especially coalescence and evolution of nanocarbides from the initial M_7C_3 to more stable $M_{23}C_6$ and M_6C, which could be directly correlated to the reduction of creep resistance.

With respect to changes in chemical composition, it was found that the role of B is summarized to facilitate the stabilization and precipitation of more stable carbides in the grain boundaries, such as $M_{23}C_6$ and fine MX. The extra amount of W promotes excessive precipitation of M_7C_3, $M_{23}C_6$ and M_6C larger carbides, with no significant benefits on the creep resistance.

The W in solid solution is the main responsible for the creep resistance in alloys 2,25Cr-W (V) and the role of the M_7C_3 and $M_{23}C_6$ carbide in aged alloys has a clear relationship with a deleterious effect on this property. Apparently, the only precipitated phases with defined role in the maintenance of resistance to creep in the alloys studied are the MX type, which remained stable under the submission of the alloys to the critical conditions of temperature, as pointed by ZHU [1] ABE [2] and BADESHA [3].

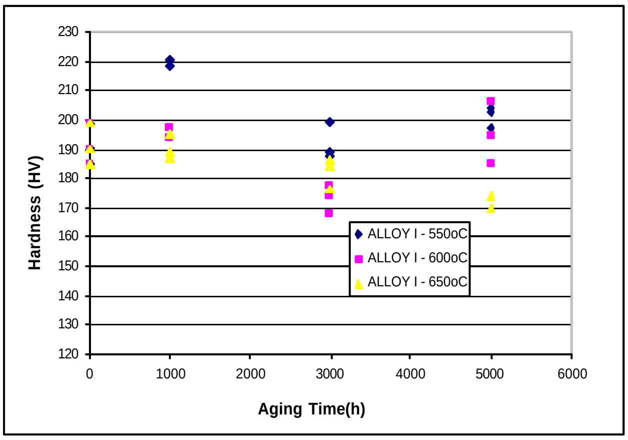

Figure 1: Hardness vs. aging time at 550°C, 600°C and 650°C (ALLOY I).

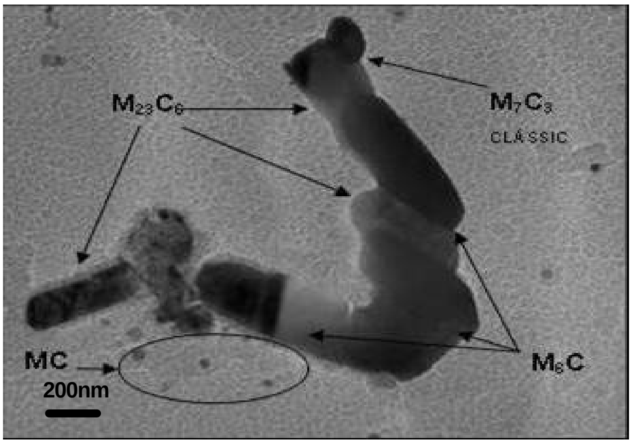

Figure 2: TEM image of carbon extraction replica (ALLOY III - 650°C/3000h).

References

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